Prototyping guide

How to use rapid prototyping to improve your product development

UltiMaker

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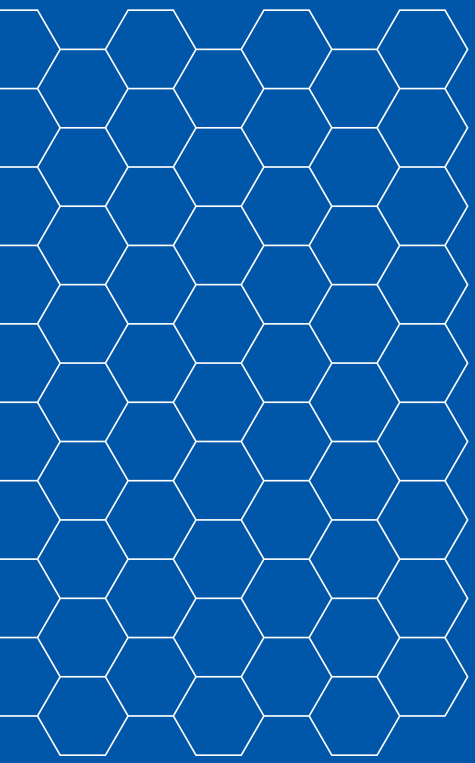
Contents



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What is rapid prototyping?

Rapid prototyping is the process of using 3D printing for quickly creating a non-final version of a physical product to test design ideas and get data that will help you improve future iterations.

Rapid prototyping allows you to try out different materials, sizes, shapes, colors, and more, to test how they affect form, fit, and function.

The goal of any rapid prototyping exercise is to make a quick version of a product that can be used to perform experiments and test assumptions. That means you need to be able to make custom one-off designs and then modify those designs in successive iterations. You need to be able to produce those iterations as quickly as possible, and the more freedom you have in designing your prototypes, the better. And of course, to justify your experiments financially, all the above requirements need to come at an affordable price. Let's take a look at how well 3D printing matches those criteria.

The history of rapid prototyping

Rapid prototyping first came into prominence in the 1980s with the rise of computer-aided design (CAD) and early additive manufacturing technologies. Rapid prototyping was also commonly referred to as solid freeform fabrication (SFF) in the past, although the term is rarely used today.

What benefits does 3D printing have for prototyping?

3D printing technology originally inspired the creation of rapid prototyping as a concept and since the technology was first developed, it has only become more suited to the task. While other manufacturing techniques such as injection molding and CNC machining can be used, 3D printing remains the most flexible and effective technology for creating your prototypes.

There are three areas in particular that make additive manufacturing well suited to prototyping:

Speed

When it comes to one-off or small-batch manufacturing, 3D printing is king. Lead times stay low because new custom molds don't need to be made and you don't need to wait for your order to be shipped. For medium-to-small objects, it's possible to create a new 3D design during the day, let it print overnight, and retrieve your completed object from the printer the next morning.

Read Quad Lock case study on Speed

Flexibility

The ability to make changes and iterate on a custom design is another area where 3D printing excels. To 3D print an object, you first need to create a digital 3D model of it. 3D models can be changed, replicated, and shared in any way you wish. If a series of experiments are unsuccessful; you can simply load up a previous version and try something else.

Read Trivium case study on flexibility

Cost

Costs vary greatly depending on part requirements and what material is used. But creating a part with similar properties using traditional forms of manufacturing such as injection molding, will nearly always be more expensive on a per-part basis for small batch or one-off prototypes.

Read NoiseAware case study on cost savings

Which 3D printing technology to use?

When choosing to use 3D printing in your prototyping process, it's important to buy the printer that most closely matches your needs. There are 5 types of distinctly different technologies that power the majority of the 3D printers currently on the market. Each can be used for prototyping and each has its own pros and cons. They are:

Printer technology	Pros	Cons
Fused deposition modeling (FDM)	• Simple to operate and maintain • Extremely large material selection • Low material cost • Low printer cost • Compact printers • Minimal post-processing required • Can print with multiple materials at once • Soluble supports can be used to simplify the support process	• Visible layer lines • Complicated support structures sometimes required • Slower print speeds
Stereolithography (SLA)	• Low maintenance requirement • Various material properties possible • High level of visual detail and accuracy • Faster print speeds in some cases • Compact printers	• UV resin is unsafe to handle without PPE • Complicated support structures almost always required • Post-processing required (support removal, cleaning, curing) • Finished parts are sensitive to UV light • Cannot print with multiple materials at the same time
Selective laser sintering (SLS)	• No support structures needed • Strong and functional parts	• High printer cost • Limited material options • Cannot print with multiple materials at the same time • Prints require a messy cleanup and result in wanted material
Polyjet/Multijet	• High level of visual detail and accuracy • Can print with multiple materials at once • Best suited for high fidelity cosmetic prototypes • Extremely fast print speeds	• High printer cost • High material costs • Post-processing required (support removal, cleaning, curing) • Finished parts are sensitive to UV light
Direct metal laser sintering (DMLS)	• Extremely strong and functional parts	• High printer cost • High material cost • Small build volume • Support structures required • Complex post-processing required

The UltiMaker S-series, perfect for rapid prototyping

The S series of UltiMaker printers are perfect prototyping machines. They have all of the advantages of FDM as a technology while also outperforming other FDM printers in a number of ways.

The S series offers

280+ materials
The widest material selection on the market for endless prototype possibilities

Dual-extrusion printing
Leverage multi-material prints and water-soluble supports

Secure cloud printing
Efficiently manage multiple printers and print queues with the UltiMaker Digital Factory

Reliable and easy to use
Spend less time testing your printer settings and more time testing your product

Learn more about UltiMaker S series

Prototype categories

In order to apply rapid prototyping effectively, you should pay special attention to what you are trying to test and what the desired outcome is. These considerations will change depending on what stage of the product development process you are in. In this section, we will outline the different categories of prototypes and how 3D printing can be applied to them.

Proof-of-concept prototype (POC)

Proof-of-concept prototypes (also known as concept models) are the earliest stage of prototyping. The goal is to test the most basic assumptions about a product with as minimal a risk as possible.

These prototypes often have zero consideration of the aesthetics or usability of the product. For this reason, POC prototypes often don't require the level of fidelity that a 3D printer provides but can still benefit greatly from the speed and low cost that 3D printing offers.

Visual prototype

Sometimes called appearance prototypes, visual prototypes are meant to demonstrate and validate how a product will look. Including its shape, size, color, and texture. The functionality of the product is of secondary concern when creating this type of prototype. Visual prototypes can help you make decisions about which final materials to use and how a product can be marketed.

3D printing can be perfect for creating visual prototypes as any combination of visual factors can be tested, especially with the large material selection that FDM printers offer. Although FDM prints may require some post-processing to perfectly match the finish of the final product. Other technologies like SLA printing can get close to approximating the look of a production-ready product straight out of the printer.

Functional prototype

Functional prototypes (also called working prototypes) are meant to demonstrate and validate the functions of a product. The visual appearance is of secondary concern when creating this type of prototype. Often, parallel prototypes will be made to test the separate functions of a single product in isolation before combining them into a more comprehensive prototype. These prototypes can help you decide which features are essential and which are impractical.

Working prototypes are where 3D printing is most suited as they are where the wide selection of available materials and material properties can be most effectively used.

Engineering/pre-production prototype

Engineering or pre-production prototypes are the final category of prototypes where the findings from all previous prototypes are married together in a near-finished product. These prototypes are commonly used to demonstrate the product to potential investors, customers, resellers, and manufacturers.

3D printing can be used to act as, or very closely approximate, end-use parts. But, they may not always be the most suited tool for doing so. This is normally the time when decisions are made about what other manufacturing techniques will be used for the final product and which, if any, will remain 3D printed.

Rapid prototyping in action

Let’s look at some of the core principles of rapid prototyping and how they can be applied with 3D printing.

Create, measure, and iterate

The power of rapid prototyping is that it allows you to speed through the build, measure, and iterate cycle as quickly as possible. Testing ideas and then adjusting based on the results is key to improving your product and doing this quickly is how you get the most out of this positive feedback loop. 3D printing is both much faster than alternative prototyping technologies and it allows you the flexibility to run a wide range of different experiments.

Eliminate flaws with exhaustive testing

Improving your product does not just mean adding functionality but also mitigating or eliminating design flaws. 3D printing has the advantage of allowing you to create every different kind of prototype including high-fidelity functional and pre-production prototypes that can be submitted to end-user testing. This enables you to still make tweaks and fixes to your product right up until the very end of the prototyping process, allowing you to avoid the heavy expense of modifying tooling and manufacturing processes down the line.

Communicate and demonstrate your ideas to others

User testing is just one of the areas that having a physical prototype can help you to gain both feedback, and buy-in from people outside of your design team.

Visual prototypes can help your colleagues in marketing to formulate a marketing plan for a product and functional prototypes can be essential in getting clients or investors excited. Slide shows and 3D renders can only go so far. Putting a physical product in someone's hand will always be more effective at demonstrating the value of a product. 3D printing allows you to do that earlier and more often than would be possible when using traditional manufacturing techniques to create your prototypes.

Speed case study: Quad Lock

Quad Lock is a Melbourne-based company that creates phone mounts for bikes and other off-road vehicles. They used UltiMaker printers to create over 100 prototypes for their vibration-damping smartphone mount for use on motorcycles.

"There's nothing faster than being able to just shoot a CAD model to the 3D printer and have it a few hours later to validate it"
— Chris Peters, Co-Founder & Chief Innovation Officer at Quad Lock

Challenge:

The Quad Lock team needed to create physical components that were strong enough to be used on test rigs and real-world applications. They also needed to create a large number of prototypes without the long development cycles that traditional production techniques require.

Read full case study

Solution:

The Quad Lock Vibration Dampner benefited from short iteration cycles thanks to UltiMaker 3D printers during both rapid concept iteration and real-world testing. Parts were able to withstand hours of testing on a vibration test rig from which the team gathered valuable feedback and data. Helping them streamline their production workflow, saving time and money.

Results:

- Over 100 prototypes created
- Able to create multiple prototypes in a single day
- A final product that went through extensive real-world testing

Flexibility case study: Trivium

Trivium is a company that specializes in sustainable and recyclable packaging that operates in over 60 countries and has over 7,500 employees. They use UltiMaker printers to save costs and keep their packaging lines running efficiently.

"First we copied the original design, we printed it in ABS but ABS wears down pretty fast so afterwards we optimized the design. We printed it again in carbon reinforced nylon. That part has been in the machine ever since." — Paul Klopper, Technical Specialist at Trivium

Challenge:

Parts used in Trivium's factories often break and are expensive to replace or are no longer available. Workers are also looking for ways to improve on existing designs to increase efficiency.

Read full case study

Solution:

3D printing provided the flexibility to create a wide range of different designs including replacement machine parts, a multi-materia replacement for a broken sensor tool, and reusable molds for creating silicone seals. Trivium were also given the flexibility to create multiple iterations and even to improve on the original parts they were replacing.

Results:

- Parts created for a wide range of different needs
- Improvements made over the original designs
- Able to leverage different material properties when needed

Cost case study: NoiseAware

NoiseAware is a company that provides noise monitoring and management solutions for high-risk, short-term rental properties like Airbnb. When developing their noise-level monitoring device, they turned to UltiMaker 3D printers to help them during the prototyping process.

"If we didn't use 3D printing on UltiMaker to assist our product development, we'd either take 10 times longer to test the product—which opens the door for a competitor—or we'd roll the dice by going to a manufacturer with less testing under our belt." — Garrett Dobbs, Head of Product at NoiseAware

Challenge:

Facing costs upwards of $20,000 (about $800 per prototype) for outsourcing their initial prototyping process, NoiseAware needed a solution for quickly creating functional prototypes that would allow field testing to improve the design.

Read full case study

Solution:

Using an UltiMaker printer, NoiseAware was able to create functional prototypes using rapid prototyping to sufficiently test their products before manufacturing final parts.

Results:

- Saved over $700 per part
- Reduced wait time for prototypes from days to hours
- Increased the reliability of their final product
- Saved the cost of their printer on a single project

Summary

We hope the information in this guide helps you leverage 3D printing to improve your rapid prototyping process. As you have seen, additive technology can help you to:

- Discover new ways to improve existing designs
- Drastically reduce the cost of your prototypes
- Dramatically increase the number of prototypes you can create
- And more...

Getting into the world of 3D printing can be daunting but it's never been easier with the reliable and intuitive printers that are now available, like the ones made by UltiMaker. If you want a printer that has the flexibility prototyping requires, consider an S series printer and gain access to over 280 materials.

And with many of our customers recouping the cost of their first printer on a single development project, there's no reason not to get started right away!

Are you ready to pioneer a new prototyping process?

Learn more about UltiMaker S-series printers

Reliable 3D printers that simply work for you

Discover the UltiMaker 3D printers that will streamline your workflow and deliver the quality results you need.

UltiMaker S7 Pro Bundle

UltiMaker S7

UltiMaker S5

What does our unique platform include?

Workhorse 3D printers that achieve fast ROI

Secure cloud software for easy remote printing

Click and print with over 240 materials

Global access to expert support and learning

Learn more →